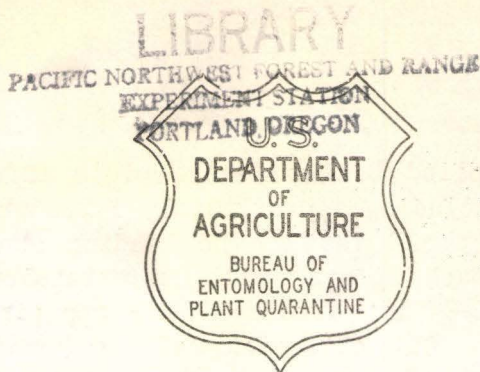




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THE EFFECTIVENESS OF CONCENTRATED SPRAYS IN THE CONTROL OF CERTAIN FOREST INSECTS

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This paper presents information, in condensed form, concerning the more important tests made with concentrated sprays against 12 species of chewing and sucking insects, 10 of which are pests of forest or shade trees. The investigations were conducted during the seasons of 1935 to 1938, inclusive, at various points in Massachusetts, Connecticut, New Hampshire, and New Jersey. Special ground equipment and an autogiro equipped with devices for atomizing and disseminating highly concentrated spray were used.

The results of these investigations are given in tables 1 and 2 and figure 1. Data are given on the insect species investigated; the kind and quantity of material applied, and the degree of effectiveness of the treatments. The sprays listed in table 1 and figure 1 were applied from the ground, while those in table 2 were applied from the air.

The first 13 mixtures of table 1 were applied to 0.02-acre plots of dense, mixed deciduous growth, 4 to 7 feet in height, by means of a quart-sized hand atomizer. Fresh foliage was taken from these plots and fed to insects held in 14-inch-square, wooden-framed trays. For each of these 13 tests, 200 larvae were placed in each of 2 trays, and a record was kept of the daily mortality of larvae feeding on sprayed foliage as compared with that of an equal number of larvae feeding on unsprayed foliage. The feeding experiments covered a period of 15 days. The effectiveness of treatment, expressed as "feeding, in percent of normal feeding" (column 7), was found by comparing the quantity of frass voided per larva feeding on sprayed foliage with the quantity of frass voided per larva feeding on unsprayed foliage.

Mixtures 14 to 17 (table 1) were applied to red pines, 6 to 10 feet high, infested with the European pine shoot moth, in areas ranging from 0.02 to 1 acre, by means of a portable, 2-gallon-capacity paint sprayer. The degree of control recorded (column 6 in the table) was found by comparing the number of larvae per 1,000 shoots on unsprayed trees with the number of larvae per 1,000 shoots on sprayed trees.

Mixture 18 was applied to two 1-acre plots infested with the white pine weevil, each plot including approximately 1,200 white pine trees which ranged in height from 6 to 12 feet. The leading shoot of each tree was sprayed by using a knapsack sprayer with an extension rod and a special nozzle (figure 1, A, in E-508) developed for applying concentrates in a solid-cone type of spray. The extension rod was bowed so that the nozzle directed the spray down on the pine leader from above. The degree of control was found by comparing the number of infested leaders per 1,000 unsprayed trees with the number of infested leaders per 1,000 sprayed trees.

Mixtures 19 to 23 were applied to plants infested with aphids, by means of the same equipment that was used for mixtures 14 to 17. The effectiveness of these mixtures was determined by comparing the number of living aphids per plant or per square foot of ground immediately before treatment with the number of living aphids 24 hours after treatment. The smallest number of aphids counted per unit of measurement before treatment was 1,148.

Figure 1 represents two series of feeding experiments (not given in the tables) with foliage from 7 plots sprayed from the ground. The tests of the first series were started immediately after the spraying, and those of the second series 15 days later. The insecticides used were lead arsenate, derris (containing 4 percent of rotenone), nicotine sulfate, derris extract (containing 25 percent of rotenone), and free nicotine. The first 3 plots were treated with standard spray concentrations, without an adhesive, by means of a knapsack sprayer. The other 4 plots were treated with concentrated sprays, containing an adhesive oil, and the same quantities of arsenical, rotenone, and nicotine were used per plot as for the standard sprays.

The mixtures of table 2 were applied by an autogiro to 40 woodland plots having a total woodland area of about 1,000 acres. In the tests with Anisota senatoria, foliage sprayed with mixtures 10 to 14 was brought from the plots to the laboratory, and the effectiveness of the treatment was determined in the same manner as described for the first 13 mixtures of table 1. In the case of all the other mixtures of table 2 the effectiveness of the treatment was found by comparing the quantity of frass recovered per 9-square-foot cloth-bottom tray in the unsprayed plot with the quantity of frass recovered per tray in the sprayed plots (column 6).

The derris extract included in the tables was in dry form and contained 25 percent of rotenone and 75 percent of other extractives. The powdered derris used contained 4 percent of rotenone. All the lead arsenate used was of the ordinary acid form.

Discussion of Results

No foliage injury resulted from the application of any of these insecticides. Good control of insects resulted from the use of all mixtures except number 6 of table 2. It is believed that poor atomization of this

mixture was partly responsible for the fact that larvae consumed 29 percent as much foliage in this plot as in the check area.

The feeding tests represented in figure 1 were made with fourth-instar larvae of Anisota senatoria (as for mixtures 9 to 13 of table 1). The results indicate that when the organic insecticides used were applied in concentrated sprays the insecticidal agent was coated sufficiently to reduce greatly the deterioration ordinarily caused by light, air, and moisture.

The residues of mixtures 10 to 14 (table 2) were exposed to 2.33 inches of rain and 10 days of weathering before the foliage was offered to the larvae. One hundred percent mortality resulted from the application of all 5 mixtures, except number 13.

In another series of tests (not given in the table) with the organic residues (mixtures 12 to 14) that had not been exposed to weathering, the feeding was from one-third to one-half less than on the residues (table 2) that had been exposed.

Drying oils and volatile oils were not so toxic to aphids as semi-drying oils. Nondrying plant oils were slightly more toxic to aphids than semidrying plant oils. When a given quantity of oil was applied as undiluted oil and as miscible oil or oil emulsion, the undiluted form was much more effective against aphids on goldenrod and asters than the diluted, emulsified water suspension. This may be due to the difference in chemical and physical properties of the two forms of spray. The results also suggested the possibility of using undiluted semidrying plant oils against sucking insects when it is necessary to avoid injury to tender plants.

Data and observations showed that, in order of increasing resistance to the insecticides applied, the insect species fell in the following order: Striped oak worm, forest tent caterpillar, eastern tent caterpillar, European spruce sawfly, gypsy moth, and cankerworms.

It was found that sawfly larvae, eastern tent caterpillars, and forest tent caterpillars were very susceptible to lime-sulfur (mixture 8, table 1) and slightly susceptible to sulfur when these two fungicides were applied as stomach poisons.

Although conventional spraying and dusting methods have not been successful against the European pine shoot moth and the white pine weevil, the application of concentrates effected good control, since it was possible to cover the buds and needles completely with a heavy insecticidal deposit. This deposit was very little affected by rain.

Table 1.--Summary of results obtained with various concentrated spray mixtures applied from the ground in 1936, 1937, and 1938

Insect species	Mixture No.	Proportion (by weight) of materials in mixture ₁ /	Pounds of insecti- cidal agent applied per acre	Gallons of total mix- ture applied per acre	Percent of mortality	Feeding, in percent of normal feeding
Forest tent caterpillar, <u>Malacosoma</u> <u>disstria</u> Hbn. (last 2 larval instars)	1 2	L.A., 1; C.O., 0.2; S.L.S., 0.03; W., 1.3 Derris, 1; C.O., 0.3; spreader A, 0.04; W., 6	10 5	2.5 4.	100 100	1.7 5.1
Eastern tent caterpillar, <u>Malacosoma</u> <u>americana</u> (F.) (last 2 larval instars)	3 4	L.A., 1; C.O., 0.2; S.L.S., 0.03; W., 1.3 Same as for No. 3	15 10	3.7 2.5	100 100	2.0 2.8
European spruce sawfly <u>Diprion</u> <u>polytomum</u> (Htg.) (last 3 larval instars)	5 6 7 8	L.A., 1; C.O., 0.2; S.L.S., 0.03; W., 1.3 Derris, 1; C.O., 0.3; spreader A, 0.04; W., 6 Derris extract, 1; C.S.O., 2; acetone, 0.5; spreader A, 0.2; W., 7 Lime-sulfur concentrate	15 15 3	3.7 12. 3.8	100 100 100	1.8 1.2 1.4
Striped oak worm <u>Anisota</u> <u>senatoria</u> (A. & S.) (fourth larval instar)	9 10 11 12 13	L.A., 1; C.O., 0.2; S.L.S., 0.03; W., 1.3 Same as for No. 9 Derris, 1; C.O., 0.3; spreader A, 0.04; W., 5.5 Derris extract, 1; C.S.O., 2; acetone, 0.5; spreader A, 0.2; W., 7 50% nicotine solution, 1; soybean oil, 3; W., 5	10 5 5 1 52/	2.5 1.3 3.8 1.2 5.5	100 100 100 97 99	0.8 1.3 1.5 2.0 1.4

European pine	14	L.A., 1; C.O., 0.3; spreader A, 0.04; W., 3	25	8.5	923/
shoot moth,	15	Same as for No. 14	10	4.3	963/
<u>Rhyaciona</u>	16	Derris, 1; C.O., 0.3; spreader A, 0.04;			
<u>buoliana</u> (Schiff.)		W., 7	25	20.	973/
	17	Same as for No. 16	10	8.	983/
White pine	18	L.A., 1; C.O., 0.3; spreader A, 0.04; W., 5	5	3.3	983/
weevil,					
<u>Pissodes strobi</u>					
(Peck)					
An aphid on	19	Soybean oil (undiluted)		5.	96
red pine	20	Derris extract, 1; acetone, 1; soybean			
		oil, 6	5	5.	100
An aphid on	21	Corn oil (undiluted)		5.	97
aster	22	Derris extract, 1; acetone, 1; C.O., 6	5	5.	100
An aphid on	23	Derris extract, 1; C.S.O., 10; white			
goldenrod		mineral oil (40 Saybolt), 30	2	10.	100

1/ L.A., lead arsenate. C.O., corn oil. S.L.S., sodium lauryl sulfate. W., water. Spreader A, alkylphenylbenzene-sulfonic acid (aresket). C.S.O., cottonseed oil.

2/ Two and one-half pounds of nicotine.

3/ These represent percentages of control instead of percent of mortality (see text for mixtures 14 to 18).

Table 2.—Summary of results obtained with various concentrated spray mixtures applied from an autogiro in 1936, 1937, and 1938

Insect species	Mixture No.	Proportion (by weight) of materials in mixture ^{1/}	Pounds of insecti- cidal agent applied per acre	Gallons of total mix- ture applied per acre	Feeding, in percent of normal feeding
Cankerworms, <u>Paleacrita</u> <u>vernata</u> (Peck) and <u>Alsophila</u> <u>pometaria</u> (Harr.)	1	L.A., 1; F.O., 0.35; P.O., 0.05; W., 2.7	22	8.8	7
Gypsy moth, <u>Porthetria</u> <u>dispar</u> (L.)	2	L.A., 1; F.O., 0.4; W., 2.7	15	6.	8.6
	3	Same as for No. 2	20	8.	6.6
	4	Same as for No. 2	30	12.	2.6
	5	C.A., 1; F.O., 0.4; W., 2.5	20	7.6	12.0
	6	Derris, 1; F.O., 0.4; W., 6	27	22.	29.0
Forest tent caterpillar, <u>Malacosoma</u> <u>disstria</u> Hbn.	7	L.A., 1; F.O., 0.4; W., 2.7	15	6	<u>2/</u>
	8	Same as for No. 7	20	8	<u>2/</u>
	9	Same as for No. 7	30	12	<u>2/</u>
Striped oak worm, <u>Anisota</u> <u>senatoria</u> (A. & S.)	10	L.A., 1; F.O., 0.24; W., 1.5	15	4.3	0.5
	11	C.A., 1; F.O., 0.24; W., 2	15	5.	0.6
	12	Derris, 1; F.O., 0.3; P.O., 0.1; spreader A, 0.04; W., 6	15	12.	5.0
	13	Derris extract, 1; acetone, 1; F.O., 3; P.O., 1; W., 18	2	6.	10.0
	14	50% nicotine solution, 1; soybean oil, 5; W., 16	<u>23/</u>	5.4	3.7

^{1/} L.A., lead arsenate. F.O., fish oil. P.O., parafin oil. W., water. C.A., calcium arsenate.

^{2/} Feeding was noticeably less than for the gypsy moth and cankerworms.

^{3/} One pound of nicotine

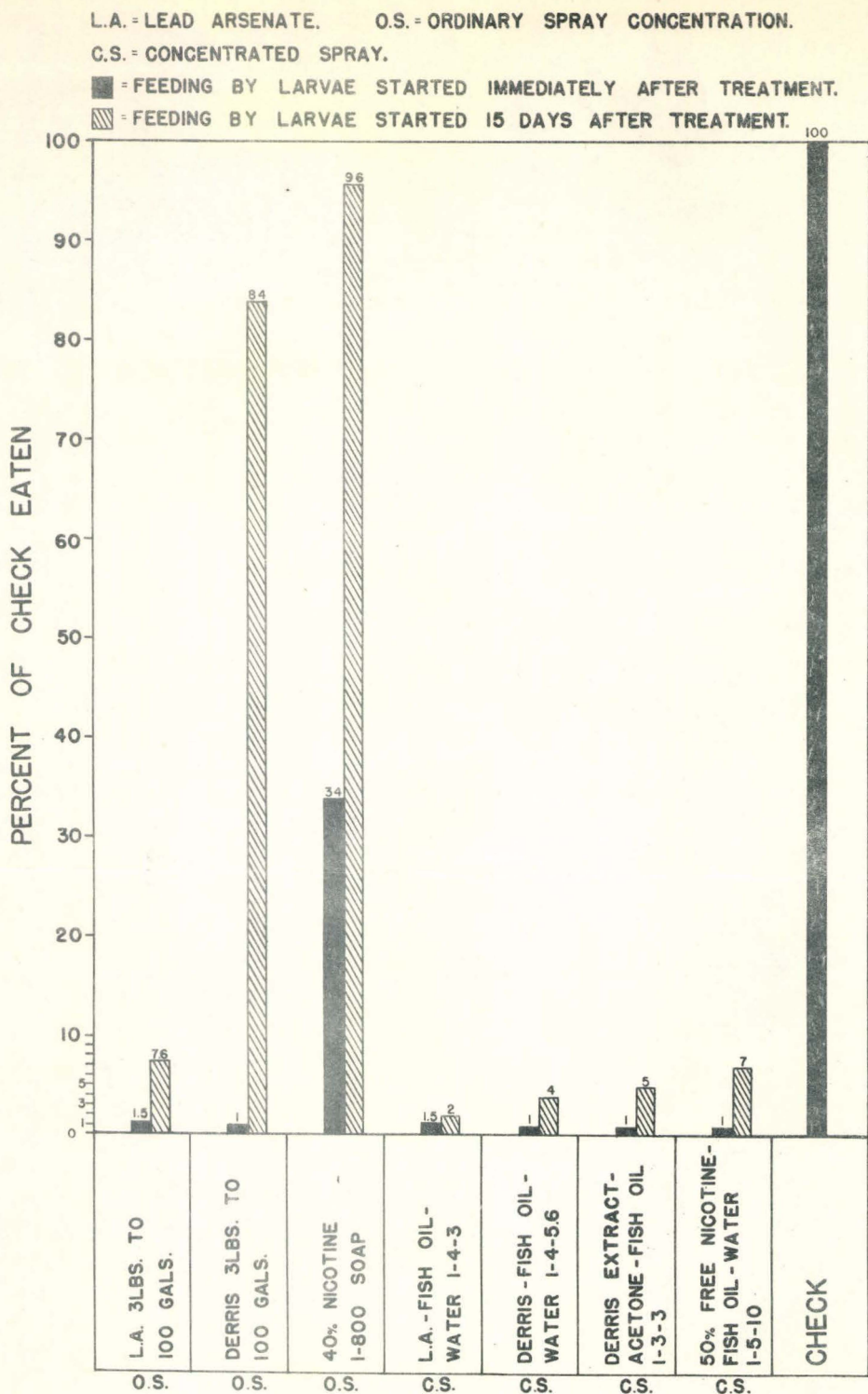


Figure 1.—Degree of effectiveness of certain organic and inorganic insecticides, in reducing the feeding of fourth-instar larvae of *Anisota senatoria*, when applied as concentrated spray mixtures, containing fish oil, before and after 1.38 inches of rain and 15 days of field exposure, as compared with three ordinary spray mixtures without fish oil.

The ingredients in the last four boxes are represented by figures as ratios, by weight. In the third box, 3 pounds of solid soap was used per pound of nicotine sulfate.

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